

Agricultural Research Institute, Pusa

**A Preliminary Note on the Behaviour in North
India of the First Batch of Sugarcane Seedlings
distributed from the Sugarcane-breeding
Station, Coimbatore**

BY

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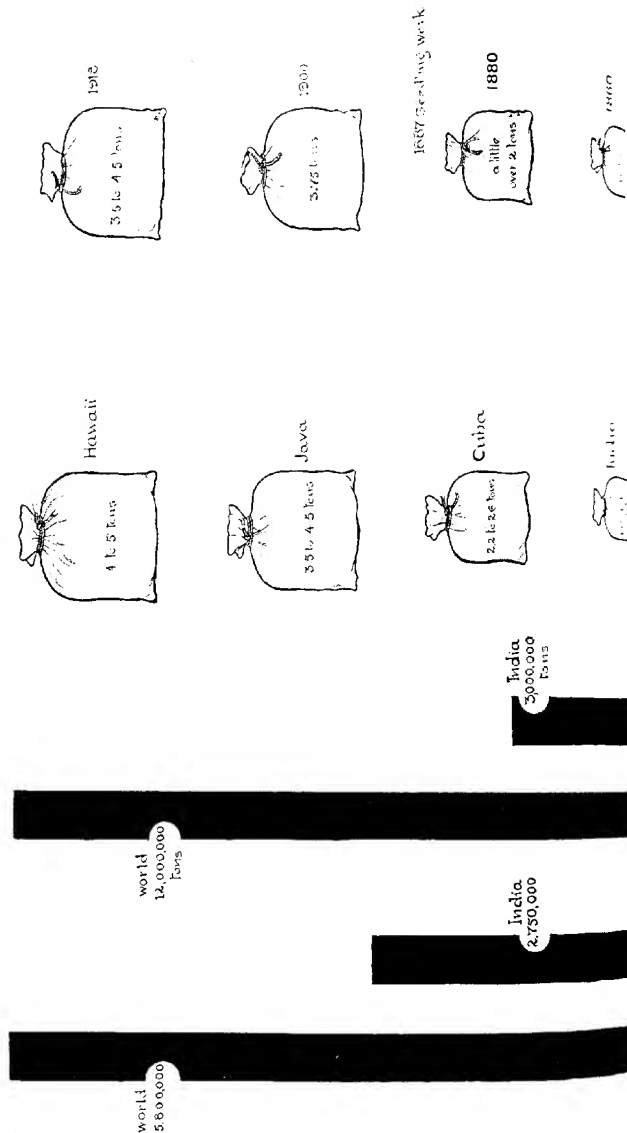
A FEW SUGARCANE FIGURES

Approximate acreage
harvested 1918

Approximate output of
raw cane sugar 1918

Approximate output of raw cane
sugar per acre in different countries

Output of raw cane sugar per
acre in Java in different years



A Preliminary Note on the Behaviour in North India of the First Batch of Sugar- cane Seedlings distributed from the Sugarcane-breeding Station, Coimbatore.

(Received for publication on 9th October 1919.)

Introduction.

THE steady increase in the quantity of white sugar imported into India, together with the depressing effect which such importations, combined with their low prices, was having on the indigenous (our (crude sugar) industry, made the Government of India, in the year 1911, direct their attention to this important industry with a view to try to put it on a satisfactory basis. The discussions on the subject, at the meeting of the Board of Agriculture in 1911, showed that the problem will have to be tackled in at least two directions, *viz.*, (1) the manufacturing or the mechanical aspect, with a view to improve the present wrong or wasteful methods; and (2) the agricultural, including the botanical aspect, with a view to improve the varieties at present grown and carry out other improvements in the methods of culture.

That the sugar industry in India is, at present, in a bad state, is evident from the figures given in the chart opposite. It is seen that, though India can boast of nearly half the world's acreage under cane, her output is only a fourth. It further contrasts the yield per acre in India with those obtained in the other cane countries, a contrast which gets all the more emphasized to India's disadvantage, when we remember that, whereas in the other countries the figures represent the quantity of refined sugar, the Indian figures are those for *gur* or *jaggery*, a more impure product. But we take heart from the fact that Java, which in the year 1860 was able to produce only about as much sugar per acre as India at the present day, has since been able to force up production in such a manner that in the year 1918 that country ranked second only to Hawaii in the matter of production per acre. In the case of India, it is doubtful, if we shall ever be able to rise to the level of the other tropical countries owing to insuperable difficulties of climate, but let us remember, that even a small increase in production will go a great way to ameliorate the position of India as a sugar-producer.

From the map of India opposite it is further evident that, to improve the Indian industry, attention will have to be concentrated on North India, chiefly the United Provinces, because (1) that province contains nearly half of India's acreage under cane, and (2) it is a vital industry in that province and sugarcane is the chief rent-paying crop, a crop "which could not easily find an equivalent in any other crop grown there." The Punjab and Bengal would come next with their one-third to half million acres under cane.

The purely botanical work, *viz.*, that of breeding a better cane for North India, was entrusted to a breeding station which in November 1912 was started at Coimbatore in the Madras Presidency under Dr. C. A. Barber, C.I.E., who was appointed Government Sugarcane Expert for all-India but with headquarters at Coimbatore. This was sought to be attained by raising canes from seed, instead of from cuttings as is ordinarily done by the ryot, a method which had already proved its utility in the other sugarcane countries of the world. The difficulties experienced in previous trials at raising cane seedlings were soon overcome—in fact even before the land intended for the station was taken possession of—and we soon had a very large number of seedlings, some of them the much-desired crosses between the thin indigenous North Indian and the thick tropical kinds.¹ But it was not until the February of 1918 that the station was able to send out the first batch of selected seedlings for trial to North Indian farms.

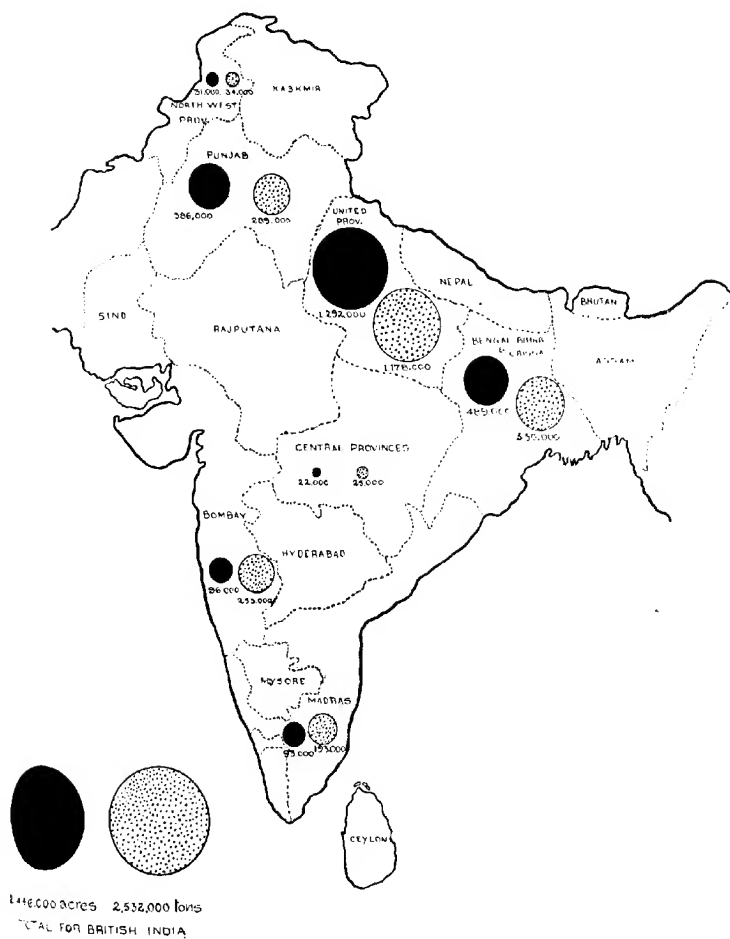
In this bulletin are presented the results of this first year's trials. The subsequent behaviour of the Coimbatore productions, when introduced into North India, has always been a matter of anxious consideration for the station; but it is fortunate that the first year's results appear to be, on the whole, encouraging. It is thought that the results thus published will not only enable the farms to take a more intelligent interest in the growing of these seedlings, but also to offer valuable suggestions for the future work of the station, which, of necessity, had to be located far away from the area for which the seedlings are intended. The station has now reached a stage when a closer connection with the North Indian farms is needed, and constant reports on the progress of the distributed seedlings will greatly help to shape the future lines of work at the station. A few photographs are included to illustrate the growth of the seedlings in the different North Indian farms.

Selection of Coimbatore as the site for the all-India Sugarcane-breeding Station.

Though the main object of the work at the Sugarcane-breeding Station, Coimbatore, was to produce for North India a cane better than

¹ The details of this work are fully described in a Memoir by Dr. C. A. Barber, C.I.E., *Mems. of the Dept. of Agri. in India, Bot. Series*, Vol. VIII, No. 3.

Map of India showing the acreage under cane & outturn of
Gur or Jaggery in the different provinces.



1. Stippled circles represent the acreages under cane in the different provinces and those with dots the total yield for the province in tons. The figures are for the quinquennium ending 1919-17.

the type now grown in that locality, the station itself had to be located at Coimbatore because the sugarcane rarely flowers in North India, and, even if it does, does not generally set seed. The selection of Coimbatore as a site for the station was amply justified soon after its foundation by the very large number of seedlings that it was found possible to raise there.

A minor disadvantage.

This selection—which as shown above was inevitable—carried with it one disadvantage, *viz.*, we had no knowledge as to how the seedlings bred and grown at Coimbatore might behave later when introduced into North India. This was fully recognized even at the outset, and, to gain some knowledge on this point, a set of seedlings—six in number—was introduced into North Indian farms even as early as 1914, *i.e.*, as soon as ever material was available for distribution.

The first batch of seedlings was in no way selected and consequently the various farms were requested to reject them from cultivation as soon as the first set of selected seedlings was available for distribution in February 1918. One of these, however, M.2, a Kahudai Boothan seedling raised in 1911-12, is still grown at Shahjahanpur as a wind-break on account of its good growth and habit (Plate V).

The first seedlings raised at the Station were mostly thick and hence unsuitable for North India.

During the early years of the station the varieties that flowered were mostly thick canes and we had but little control over the parents. The seedlings produced were consequently mostly thick and so unsuitable for introduction into North India. Later on, however, it was found possible to induce many of the thin canes also to flower at the station. This, together with the steadily increasing knowledge of the different parents¹ gained in the meanwhile, enabled the station to plant out, for the season 1917-18, a crop of seedlings more than 50 per cent. of which were of a type suitable to be grown in North India.²

The first distribution to North India was made in February 1918.

This enabled the station to send out its first batch of selected seedlings in February 1918. But a new difficulty presented itself. The final

¹ Venkatraman, T. S. "Study of arrowing in the sugarcane." *Agri. Journal of India*, Special Indian Science Congress Number, 1917.

² It is perhaps worth mentioning here that though it has been possible to effect crosses, between thick canes and most of the groups that occur in North India, the two classes represented by (1) Nargori, Kewali, Sararo, etc., and (2) Mungo, Hemja, theora, Burli Kuswar, etc., offer special difficulties because these do not flower under Coimbatore conditions and, even if they do, produce only unhealthy flowers. These are at the same time very desirable parents, and any information on the arrowing (flowering) of these varieties in any locality will be welcome.

chemical analyses figures for the 1917-18 crop would be available only in March-April, while the North Indian farms wanted the seedlings at least in February—the general planting season in North India. At this stage the accumulated analytical experience was called in for aid. It was found that the final analyses figures varied correspondingly with the results obtained in February when the crop is on the whole immature. This justified the distribution of the seedlings on a comparative basis and saved a whole year for the work.

A statement is appended giving the distribution as made in February 1918. In response to individual requests from the different farms a certain amount of information about the parentages of the different seedlings is also included. Besides the thin seedlings and thin canes mentioned in this statement, certain thick seedlings and varieties were distributed to certain Madras farms, to Hebbal and to Manjri, but their growth in this, the first year, does not justify their inclusion in this report.

Statement showing the distribution of thin seedlings and varieties in February 1918.

(A cross mark placed against a locality indicates that the cane was distributed to that locality.)

Name of seedling or variety	PLACES TO WHICH DISTRIBUTED.									Notes on parentage, origin, etc.
	Bangalore	Munjeri	Gwalior	Gardasput	Shajahampore	Cawnpore	Pusa	Sepaya	Tharsa	
Co. 201	x	x	x	x	x		x	x	x	Punjab seedling. General collection. Selfed of possible cross with M. 2 or M. 1017, two vigorous Madras seedlings of rather low sucrose.
Co. 202	x	x	x	x	x		x	x	x	Chittan seedling. General collection. "Rogue" type. Chittan is a thick striped cane occurring round about Coimbatore.
Co. 203	x	x	x	x	x		x	x	x	Saretha seedling. General collection. Very likely selfed.
Co. 204	x	x	x	x	x		x	x	x	Chittan seedling. General collection. Some vigorous Naamal seedlings, which possess an abundance of healthy pollen, were flowering on the windward side; and cross-pollination with these is highly probable. Arrows of Chittan, collected under conditions, where selfing was the most likely, gave a different type of seedlings.
Co. 205	x	x	x	x	x		x	x	x	Volat x Saccharum spontaneum. Bagged cross. The mother arrow possessed very little pollen (2 per cent.) slightly open anthers, and no other stray pollen was kept out by enclosing the mother arrow in a muslin bag it may be taken to be a cross between the parents indicated.
Co. 206	x	x	x	x	x		x	x	x	Asy. Mauritius seedling. General collection. "Rogue" type.

Panshi seedling. General collection.¹
 Selfed or possible cross with M. 2 or M. 1017, two vigorous Madras seedlings of rather low sucrose.
 Chittan seedling. General collection.
 "Regue" type. Chittan is a thick striped cane occurring round about Coimbatore.
 Suretha seedling. General collection.
 Very likely selfed.
 Chittan seedling. General collection.
 Some vigorous Naanal seedlings, which possess an abundance of healthy pollen, were flowering on the windward side; and cross-pollination with these is highly probable. Arrows of Chittan, collected under conditions, where selfing was the most likely, gave a different type of seedlings.
 Vellat x Suretham spontaneous. Bagged cross.
 The mother parent possessed very few (2 per cent.) slightly open anthers, and as other stray pollen was kept out by enclosing the mother arrow in a muslin bag it may be taken to be a cross between the parents indicated.
 Ashly Mauritius seedling. General collection.
 "Regue" type.

Statement showing the distribution of thin seedlings and varieties in February 1918 — *contd.*

Name of seedling or variety	PLACES TO WHICH DISTRIBUTED.						Notes on parentage, origin, etc.
	Bangalore	Manjri	Gwalior	Gurdaspur	Shajahanpore	Cawn-pore	
Co. 207			×		×	×	J.213 × Saretha. Unbagged cross. The mother arrow had practically no healthy pollen, therefore not selfed. Saretha pollen was constantly dusted over the stigmas when they were receptive, so Saretha is the likeliest male parent. The mother arrow was not protected by muslin bag, so remote chances of cross-pollination with other varieties, chiefly M.2.
Co. 208		×	×		×	×	J.213 seedling. General collection. This variety has no healthy pollen, therefore not selfed. Likely crosses with M.2 or M.1017, two vigorous Madras seedlings of rather low sucrose which were flowering freely in the neighbourhood.
Co. 209			×		×		Kleda seedling. General collection. Very likely selfed. This variety possesses abundant fertile pollen and no others were flowering in the vicinity at the time.
Co. 210		×	×		×	×	J.213 seedling. General collection. This variety has no healthy pollen, therefore not selfed. Likely crosses with M.2. or M.1017, two vigorous Madras seedlings of rather low sucrose which were flowering freely in the neighbourhood.
Co. 211					×	×	Green Sport of Striped Mauritius × Saretha. Unbagged cross. The mother variety has a fair quantity of its own pollen, so may be a selfed seedling. The stigma was constantly dusted with Saretha pollen, so Saretha is a likely male parent. With such an abundance of fertile pollen, possibility of cross-pollination with other varieties flowering in the vicinity is very

Explanation of the terms "Bagged" and "Unbagged" crosses with a short note on the methods of crossing in sugarcane current at the Cane-breeding Station.

These two terms require a certain amount of explanation for their being properly understood. Crossing in the sugarcane presents peculiar difficulties, as emasculation is practically entirely ruled out owing to the extreme delicacy of the floral structures; even a prolonged bending of the main axis has been known to result in the complete drying up of the arrow. Fortunately, however, we have in the cane, certain varieties which are male sterile in different degrees. If this male sterility is absolute, we can, by enclosing such flowers in muslin bag and introducing into it some known pollen, obtain a cross, about the male and female parentages of which we can assume a high degree of certainty. Such a one is Co. 205. If, however, the mother shows a certain degree of male fertility and we introduce some other known pollen—keeping the arrow under bag—the resultant seedlings will either be selfed or cross-pollinated with a known father. Both these are referred to as "bagged crosses" in the above statement.

It was found, however, that bagging an arrow frequently exerted an adverse influence on its seed-setting¹; and therefore in later years crossing was frequently done by merely marking the mother arrows in the field and keeping them constantly dusted with some known pollen till the stigmas were found to wither. These are called "unbagged crosses." In these the male parents are only probable as there is an ever-present possibility of any stray wind-borne pollen getting access to the stigmas. The parentage becomes yet more uncertain, when, as in the cases of Cos. 214, 215, and 216, the mother arrow possesses fertile pollen of its own, for there then arises three different distinct possibilities as to the parentage of the resultant seedlings.

- (a) Selfed,
- (b) Cross with the pollinated father,
- (c) Cross with some unknown parent through some stray wind-borne pollen.

The above remarks may perhaps convey to the reader an impression as to the futility of parentage notes in cases like those of Cos. 214, 215 and 216, but against it the following considerations are advanced:—

- (1) In the absence of more accurate information, it is an advantage to know at least the most likely parents, in following the behaviour of such seedlings in future years.

¹ Venkatraman, T. S. "Study of arrowing in the sugarcane." *Agri. Journal of India*, Special Indian Science Congress Number, 1917.

- (2) In the character of the resultant seedlings, we occasionally get some indications by which it is possible to guess the male parents with a certain degree of certainty.
- (3) With the Breeding Station sanctioned only for a limited period, the purely utilitarian aspect had to be prominently kept in view, and, so far, the results would appear to justify the means employed.

Selection of types for each locality.

In the distribution an attempt was made to pick out the seedling with an eye to the cane now successfully grown in each locality, but it is felt that it will be sometime before much specialisation is possible in this direction. The annual visits by the staff of this office and the periodic reports from the different farms will, it is hoped, soon yield valuable data on this question.

A method to minimise "personal equation" in the selection work at the Cane breeding Station.

One very important qualification for a breeder is the ability to quickly compare with one another different plants or strains with a view to selection and propagation. Such a valuation has often to be made on a large number of characters and this is a matter in which "personal equation" is likely to play not an insignificant part. That this work of comparing and selecting is not a light one at the Cane-breeding Station, will be readily conceded, when it is realized that each year the station has as many as 5,000 new seedlings and 600 already selected ones in different stages of filtration, from which to pick material for further trial and propagation.

The method described.

To systematize this work as far as possible and to guarantee that each character gets its due recognition in the final estimate a system of marking was introduced. A list was prepared of the characters considered important in forming the estimate and each allotted a maximum of ten marks. All the seedlings were then examined for some particular character at a time and marks noted against each in proportion to its merits. This process was then repeated for each of the other characters on the list and the totals made up for each seedling. A large number of marks, in the totals thus arrived at, will indicate the satisfactory nature of the seedling in most or all the characters and it is therefore safe to make the selections on this basis.

The behaviour of the distributed seedlings in the different North Indian farms during the first year of trial.

This method, having proved itself useful at the Cane-breeding Station for some time, was adopted in a tour to North India (in December 1918 to January 1919) undertaken with the special object of studying the behaviour of the distributed seedlings in that locality. Besides notes on health, height, arrowing, length of formed cane, thickness of canes, etc., marks were given for four important field characters, viz. :—

- (1) Stand or germinating capacity.
- (2) Vigour or weight of harvest.
- (3) Habit, *i.e.*, whether the canes in the clump stand upright, or are slanting, or fall about in all directions seriously interfering with subsequent cultural operations. Further the straightness of canes is a character of considerable importance in (1) the transport to the factory in carts, and (2) the packing on the hoppers at the mill.
- (4) Tillering, *i.e.*, the number of canes per stool at harvest. This is included in No. 2, but was thought of sufficient importance to be separately considered.

The table hereunder gives the marks obtained by each distributed seedling for the above four characters in each of the farms visited. In the remarks column will be found some tentative notes on the parentages considered likely to be useful in the different tracts.

Statement of marks obtained by the distributed seedlings in the different farms with notes on the percentages likely to be useful in the different tracts. (See Plates I, II, III, IV, V, VI for comparison of growth).

Co. Nos.	Sugarcane Stations Coimbatore	Bangalore	Mandri	Tharasa	Pusa	Sapaya	Channore	Shalghat-Pat	Gurdaspur	REMARKS
Co. 201	322 6, 10, 8, 8.	30 8, 7, 8, 7.	26 10, 0, 10, 7.	32 9, 7, 9, 7.	28 6, 7, 8, 7.	32 0, 8, 0, 6.	..	32 0, 0, 0	22 6, 6, 5.	(1) The two figures against each seedling mark represents the aggregate marks obtained by the seedling for all the four tracts. (2) The first figure represents the marks for each character, for (1) Stalk, (2) Vigour, (3) Habit and (4) All-roundness. (3) The second figure represents the marks for each character was fixed at ten.
Co. 202	330 10, 9, 10.	23 6, 4, 7.	33 9, 8, 8.	27 9, 5, 8.	28 8, 3, 6.	32 0, 8, 0, 6.	..	32 8, 7, 10.	22 8, 9, 10, 6.	(4) The two figures against each seedling mark represents the aggregate marks obtained by the seedling for all the four tracts. (5) The first figure represents the marks for each character, for (1) Stalk, (2) Vigour, (3) Habit and (4) All-roundness. (3) The second figure represents the marks for each character was fixed at ten.
Co. 203	335 6, 7, 8, 4.	25 6, 7, 4, 8.	28 8, 6, 0, 8.	17 5, 4, 1, 6.	13 3, 3, 3, 3.	29 0, 8, 0, 6.	..	32 4, 3, 3.	22 1, 5, 2.	(5) The two figures against each seedling mark represents the aggregate marks obtained by the seedling for all the four tracts. (6) The first figure represents the marks for each character, for (1) Stalk, (2) Vigour, (3) Habit and (4) All-roundness. (3) The second figure represents the marks for each character was fixed at ten.
Co. 204	344 10, 9, 7.	26 6, 6, 6, 7.	38 10, 8, 0, 0.	20 4, 6, 6, 0.	31 3, 6, 3, 3.	29 0, 8, 0, 6.	..	32 8, 10, 6.	22 10, 7.	(6) The two figures against each seedling mark represents the aggregate marks obtained by the seedling for all the four tracts. (7) The first figure represents the marks for each character, for (1) Stalk, (2) Vigour, (3) Habit and (4) All-roundness. (3) The second figure represents the marks for each character was fixed at ten.
Co. 205	290 6, 7, 9, 7.	26 6, 6, 6, 7.	38 10, 8, 0, 0.	20 4, 6, 6, 0.	31 3, 6, 3, 3.	29 0, 8, 0, 6.	..	32 8, 10, 6.	22 10, 7.	(7) The two figures against each seedling mark represents the aggregate marks obtained by the seedling for all the four tracts. (8) The first figure represents the marks for each character, for (1) Stalk, (2) Vigour, (3) Habit and (4) All-roundness. (3) The second figure represents the marks for each character was fixed at ten.
Co. 206	310 10, 10, 8.	26 6, 6, 6, 7.	38 10, 8, 0, 0.	20 4, 6, 6, 0.	31 3, 6, 3, 3.	29 0, 8, 0, 6.	..	32 8, 10, 6.	22 10, 7.	(8) The two figures against each seedling mark represents the aggregate marks obtained by the seedling for all the four tracts. (9) The first figure represents the marks for each character, for (1) Stalk, (2) Vigour, (3) Habit and (4) All-roundness. (3) The second figure represents the marks for each character was fixed at ten.
Co. 207	311 10, 10, 8.	26 6, 6, 6, 7.	38 10, 8, 0, 0.	20 4, 6, 6, 0.	31 3, 6, 3, 3.	29 0, 8, 0, 6.	..	32 8, 10, 6.	22 10, 7.	(9) The two figures against each seedling mark represents the aggregate marks obtained by the seedling for all the four tracts. (10) The first figure represents the marks for each character, for (1) Stalk, (2) Vigour, (3) Habit and (4) All-roundness. (3) The second figure represents the marks for each character was fixed at ten.
Co. 208	312 10, 10, 8.	26 6, 6, 6, 7.	38 10, 8, 0, 0.	20 4, 6, 6, 0.	31 3, 6, 3, 3.	29 0, 8, 0, 6.	..	32 8, 10, 6.	22 10, 7.	(10) The two figures against each seedling mark represents the aggregate marks obtained by the seedling for all the four tracts. (11) The first figure represents the marks for each character, for (1) Stalk, (2) Vigour, (3) Habit and (4) All-roundness. (3) The second figure represents the marks for each character was fixed at ten.
Co. 209	313 10, 10, 8.	26 6, 6, 6, 7.	38 10, 8, 0, 0.	20 4, 6, 6, 0.	31 3, 6, 3, 3.	29 0, 8, 0, 6.	..	32 8, 10, 6.	22 10, 7.	(11) The two figures against each seedling mark represents the aggregate marks obtained by the seedling for all the four tracts. (12) The first figure represents the marks for each character, for (1) Stalk, (2) Vigour, (3) Habit and (4) All-roundness. (3) The second figure represents the marks for each character was fixed at ten.
Co. 210	314 10, 10, 8.	26 6, 6, 6, 7.	38 10, 8, 0, 0.	20 4, 6, 6, 0.	31 3, 6, 3, 3.	29 0, 8, 0, 6.	..	32 8, 10, 6.	22 10, 7.	(12) The two figures against each seedling mark represents the aggregate marks obtained by the seedling for all the four tracts. (13) The first figure represents the marks for each character, for (1) Stalk, (2) Vigour, (3) Habit and (4) All-roundness. (3) The second figure represents the marks for each character was fixed at ten.
Co. 211	315 10, 10, 8.	26 6, 6, 6, 7.	38 10, 8, 0, 0.	20 4, 6, 6, 0.	31 3, 6, 3, 3.	29 0, 8, 0, 6.	..	32 8, 10, 6.	22 10, 7.	(13) The two figures against each seedling mark represents the aggregate marks obtained by the seedling for all the four tracts. (14) The first figure represents the marks for each character, for (1) Stalk, (2) Vigour, (3) Habit and (4) All-roundness. (3) The second figure represents the marks for each character was fixed at ten.
Co. 212	316 10, 10, 8.	26 6, 6, 6, 7.	38 10, 8, 0, 0.	20 4, 6, 6, 0.	31 3, 6, 3, 3.	29 0, 8, 0, 6.	..	32 8, 10, 6.	22 10, 7.	(14) The two figures against each seedling mark represents the aggregate marks obtained by the seedling for all the four tracts. (15) The first figure represents the marks for each character, for (1) Stalk, (2) Vigour, (3) Habit and (4) All-roundness. (3) The second figure represents the marks for each character was fixed at ten.
Co. 213	317 10, 10, 8.	26 6, 6, 6, 7.	38 10, 8, 0, 0.	20 4, 6, 6, 0.	31 3, 6, 3, 3.	29 0, 8, 0, 6.	..	32 8, 10, 6.	22 10, 7.	(15) The two figures against each seedling mark represents the aggregate marks obtained by the seedling for all the four tracts. (16) The first figure represents the marks for each character, for (1) Stalk, (2) Vigour, (3) Habit and (4) All-roundness. (3) The second figure represents the marks for each character was fixed at ten.
Co. 214	318 10, 10, 8.	26 6, 6, 6, 7.	38 10, 8, 0, 0.	20 4, 6, 6, 0.	31 3, 6, 3, 3.	29 0, 8, 0, 6.	..	32 8, 10, 6.	22 10, 7.	(16) The two figures against each seedling mark represents the aggregate marks obtained by the seedling for all the four tracts. (17) The first figure represents the marks for each character, for (1) Stalk, (2) Vigour, (3) Habit and (4) All-roundness. (3) The second figure represents the marks for each character was fixed at ten.
Co. 215	319 10, 10, 8.	26 6, 6, 6, 7.	38 10, 8, 0, 0.	20 4, 6, 6, 0.	31 3, 6, 3, 3.	29 0, 8, 0, 6.	..	32 8, 10, 6.	22 10, 7.	(17) The two figures against each seedling mark represents the aggregate marks obtained by the seedling for all the four tracts. (18) The first figure represents the marks for each character, for (1) Stalk, (2) Vigour, (3) Habit and (4) All-roundness. (3) The second figure represents the marks for each character was fixed at ten.
Co. 216	320 10, 10, 8.	26 6, 6, 6, 7.	38 10, 8, 0, 0.	20 4, 6, 6, 0.	31 3, 6, 3, 3.	29 0, 8, 0, 6.	..	32 8, 10, 6.	22 10, 7.	(18) The two figures against each seedling mark represents the aggregate marks obtained by the seedling for all the four tracts. (19) The first figure represents the marks for each character, for (1) Stalk, (2) Vigour, (3) Habit and (4) All-roundness. (3) The second figure represents the marks for each character was fixed at ten.

"Arrowing" and "smutting" of the distributed seedlings in the different farms.

Tendency to arrow and liability to smut are serious drawbacks in any distributed seedling and the statement below gives the record for the seedlings in respect of these two characters at the time of examination. The upper figure gives the note on "arrowing" and the lower one on "smutting."

Distributed Co. seedlings	Character studied	Cane-breeding Station, Coimbatore	Bangalore	Madurai	Tamilor	Tharur	Puduk	Seppaya	Cannore	Sheshbhanpur	Coimbatore	REMARKS
Co. 201	Ar.	Nil	Few	Prof.		Nil	Nil	Nil	..	Nil	Nil	<p>(1) Note the special liability to smut in the Saretha seedling—Co. 202, and Khidia seedling—Co. 209.</p> <p>(2) Seedlings with J. 213 or Saretha as either of the parents show similar liability to smut.</p> <p>The above parents will, therefore, have to be used with very great caution in breeding cane for a locality where smut is a serious consideration.</p>
	Sm.	Nil	Nil	Nil		1 slit.	Nil	Nil	..	Nil	Nil	
Co. 202	Ar.	Few	Prof.	Prof.		Prof.	Mod.	1 Ar.	..	Nil	Nil	
	Sm.	Nil	Nil	Nil		1 slit.	Nil	Nil	..	Nil	Nil	
Co. 203	Ar.	Nil	Prof.	Nil		Prof.	Mod.	..	..	Nil	Nil
	Sm.	Few	1 slit.	Nil		Nil	1 slit.	Bad	..	Bad	Nil	
Co. 204	Ar.	Prof.	Prof.	Prof.		Prof.	Nil	Nil	..	Nil	Nil	
	Sm.	Nil	Nil	Nil		Nil	Nil	Nil	..	Nil	Nil	
Co. 205	Ar.	Nil	Prof.	Prof.		Prof.	Prof.	Prof.	..	Nil	Nil	
	Sm.	Nil	Nil	Nil		Nil	Nil	Nil	..	Nil	Nil	
Co. 206	Ar.	Prof.	Prof.	Prof.		Prof.	Nil	Nil	..	Nil	Nil	
	Sm.	Nil	Nil	Nil		Nil	Nil	Nil	..	Nil	Nil	
Co. 207	Ar.	Nil	..	..		Nil	Nil	Nil	..	Nil	..
	Sm.	Nil	..	..		Nil	Nil	Nil	..	Few	..

conditions and no notes could be recorded.

Co. 208	Ar.	Nil	...	Few	The seedlings showed poor growth because of abnormal weather					Nil	Nil	Nil	1 sht. ?	...
	Sm	Nil	...	Nil						Nil	Nil	Nil	...	...
Co. 209	Ar.	Nil	...	...	Nil	Nil	Nil	Nil	...	...	...	...	...	...
	Sm.	Nil	...	...	Nil	Nil	Nil	Nil	...	...	...	...	...	...
Co. 210	Ar.	Nil	...	Few	Nil	Nil	Nil	Nil	...	...	...	...	...	...
	Sm.	Few	...	Nil	Nil	Nil	Nil	Nil	...	...	...	...	...	...
Co. 211	Ar.	Nil	...	...	...	Nil	Nil	Nil	...	...	...	...	...	...
	Sm.	Few	...	...	...	Nil	Nil	Nil	...	...	...	...	...	...
Co. 212	Ar.	Few	...	Few	...	Nil	Nil	Nil	...	...	...	...	...	...
	Sm.	Nil	...	Nil	...	Nil	Nil	Nil	...	...	...	...	...	...
Co. 213	Ar.	Nil	...	...	...	Nil	Nil	Nil	...	...	...	...	...	...
	Sm.	Nil	...	...	...	Nil	Nil	Nil	...	...	...	...	...	...
Co. 214	Ar.	Nil	...	...	...	Few	Nil	Nil	...	...	...	...	...	...
	Sm.	Few	...	...	...	Nil	Nil	Nil	...	...	...	...	...	...
Co. 215	Ar.	Few	...	...	...	Nil	Nil	Nil	...	...	...	...	...	...
	Sm.	Few	...	...	...	Nil	Nil	Nil	...	...	...	...	...	...
Co. 216	Ar.	Few	...	...	...	Nil	Nil	Nil	...	...	...	...	...	...
	Sm	Nil	...	...	...	Nil	Nil	Nil	...	...	...	...	...	...

¹ These seedlings were destroyed at this farm owing to the appearance of smut.

Prof. = Profuse.

Mo. = Moderate in number or quantity.

Sht. = Shoot

... = The seedling was not available for observation generally because of not having been distributed.

Arrowing in canes has no immediate harmful effect on the sucrose contents, but leads to the stoppage of all further vegetative growth and the formation of pith in the centre if the crop is kept in the ground long after the arrowing. The notes on arrowing, recorded above, show that this character in a seedling need not deter us from distributing it to a place like Gardaspur. It rises to a position of some importance when distributing to places similar to Shahjahanpur, Sepaya and Pusa, while serious note will have to be taken of this character when considering distribution to places like Manjri, Hebbal and Tharsa. (I. Plate VI.)

Similarly, tendency to smut in a seedling is not apparently a matter for serious consideration in the Punjab. It is a very serious drawback in a seedling intended to be distributed to the United Provinces, Sepaya—where the Farm Superintendent entirely destroys the crop on the first appearance of smut in the field—and Pusa. In places like Manjri, Hebbal and Tharsa it is apparently not of much account. In some of these localities the late-formed lateral shoots often regularly show smut and the crop does not appear to suffer much in consequence.

Chemical analyses of the distributed seedlings.

Lastly the sucrose contents of the seedlings is a character of great importance and the present distributions have accordingly been analysed in the different farms. It is to be remembered, however, that the analyses figures are not strictly comparable, because, (1) of the smallness of the samples analysed, (2) of the possibility that at the time of analyses the seedlings may not have been equally ripe in all the places, (3) of differences in the methods of analyses followed at the various stations. The various officers have very kindly forwarded the analyses figures for comparison and these are published in the statement herewith appended.

Character of the Juice of the Coimbatore seedlings in different localities.

Locality.	Co. 213			Co. 214			Co. 215			Co. 216		
	Dix.	Sucrose.	Glucose.	Co-efficient of purity.	Dix.	Sucrose.	Glucose.	Co-efficient of purity.	Dix.	Sucrose.	Glucose.	Co-efficient of purity.
Sugarcane-breeding Station, Coimbatore	%	%	%	%	%	%	%	%	%	%	%	%
Mudji	17.80	12.13	..	76.1	10.46	16.22	..	82.1	17.04	13.71	15.62	78.1
Tharsa	..	..	..	..	..	..	..	..	..	..	..	..
Sunabilla, 14-25 per cent. Su. in Juice, Khadi, 12.12 and J. 24.7, 16.61.	..	..	..	..	..	..	..	..	..	..	..	..
Pusa	16.34	12.69	1.01	85.6	18.88	10.56	6.13	87.9	17.50	11.15	11.68	78.0
Murchi, 15.07 per cent. Su. in Juice, Kuswar 15.44 and J. 24.7, 15.19.	..	13.25	6.31	85.2	..	18.67	6.28	93.0	..	16.24	6.29	95.3
Sepoya	..	..	..	..	..	..	..	..	..	..	..	..
Shahjhanpur	..	8.73	2.61	..	..	12.56	1.32	..	..	11.02	1.71	..
Highest averages in selected varieties under field conditions 12.6, 8.6, 2.9, 1.1, 1.1.	..	..	..	..	..	..	..	..	..	..	..	..
Gurugur	..	13.11	1.92	89.7	..	17.96	0.37	87.5	..	12.71	0.96	79.1
The average of a number of analyses of Dindin was 11.66 per cent. sucrose in Juice.	..	..	..	..	..	..	..	..	..	..	..	..

Note 1. All available analyses figures are given in this statement.

Note 2. The analyses were made on the juice of the seedlings and have been distributed.

Note 3. All the cane-in-silage station seedlings were analysed three times and the highest figures are here recorded. Some of the analyses did not include glucose determinations and hence the absence of these figures in a few cases.



Co. 202

Co. 201



Co. 204

Co. 203



Co. 206

Co. 205

Calamagrostis canadensis (Michx.) Link. *Calamagrostis canadensis* (Michx.) Link.



Co. 210 Co. 209 Co. 208
Culabatore seedlings at the Tharsa Farm. The growth was so good that some of them had to be heavily supported with lamboog.



J. 217 Khari and Sumabile cut the Tharsa Farm;
Some of the promising canes grown by the local Agricultural Department.
The range seen in the pictures has alternate foot spaces marked black and white and is placed to enable comparison of height of growth.

PLATE III



Coinbatore seedlings at the Cattle-breeding Station, Serpaya.

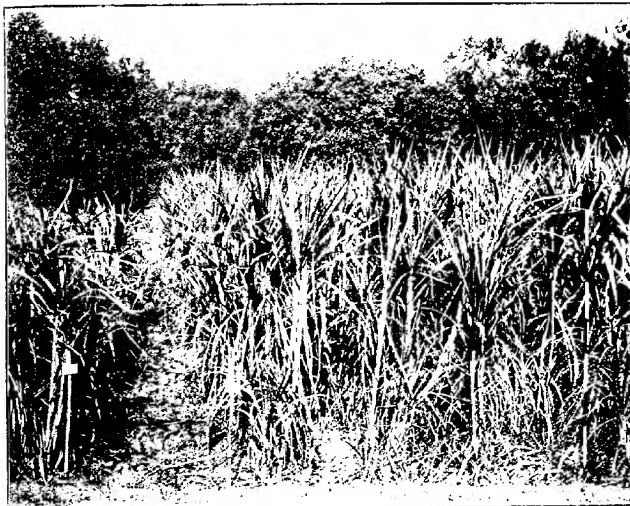
Note the free growth and satisfactory habit.

The gauge seen in the pictures has alternate foot spaces marked black and white and is placed to enable comparison of height of growth.

PLATE IV



The tall row of canes seen in the picture is that of Co. 210 grown at the Cawnpore Farm. The growth is very promising.



The bulk crop seen in the picture is of J. 33a grown at Cawnpore for seed. To the left are seen a few rows of Ashy Mauritius. The gauge seen in the pictures has alternate foot spaces marked black and white and is placed to enable comparison of height of growth.



A cane plot at the Sirajpetalur Forestry Research Station. The two rows to the right are of M. 2, a Madras seedling raised in 1911-12. This seedling has a low sucrose but is grown as a wild-break because of its good growth and excellent habit.



Coimbatore seedlings at the Pusa sugarcane area. From left to right; Karun, Ces. 207, 206, 205, 204, 203, 202, 201, and Kuswar. Karun is a thick cane introduced from Coimbatore, and Kuswar a thin dwarf North Indian cane. Note the comparative better growth of the Coimbatore seedlings. Some of these have arrowed freely here. The gauge seen in the pictures has alternate feet spaces marked black and white and is placed to

PLATE VI



Arrowing of the distributed seedlings at Manji Farm.



Co. 2011

Co. 2013

Co. 2012

Arrowing of the distributed seedlings at Tharsa Farm.

The gauge seen in the pictures has alternate foot spaces marked black and white and is placed to enable comparison of height of growth.

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**A Summary of the Experiments on Rice in
Bihar and Orissa from 1912 to 1919**

BY

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A Summary of the Experiments on Rice in Bihar and Orissa from 1912 to 1919

(Received for publication on 19th January, 1920.)

THE various experiments which are summarised in this paper were carried out in order to discover the best methods of cultivating rice in Bihar and Orissa both from the point of view of outturn and of profit. They were mostly undertaken on land which could be irrigated at least occasionally and are concerned with questions of ploughing, seed selection, sowing, transplanting and manuring. As is usually the case with a summary of experiments which has to be given at a specified date, some of the questions investigated have not yet been sufficiently examined, in others the results are indefinite; nevertheless various conclusions may be drawn.

For the sake of clearness I have divided the paper into four parts.

- A. Introduction.
- B. A summary of the experiments in cultivation.
- C. A summary of the experiments in the use of manures.
- D. Conclusions that, I think, may be drawn.

A. Introduction.

Although experiments were carried out before 1912-13, I have thought it preferable to commence with that date because up to that time there was only one Deputy Director in charge of all the farms in the province (which is roughly the size of France), and it was impossible for him to give the experiments close personal supervision. The consequence was that as the farm staffs were for the most part untrained in experimental work and lacking in the spirit of impartial scientific enquiry many of the results were inaccurate.

I arranged the experiments on the Bankipore and Dumraon Farms up to 1916-17 inclusive, after which they were designed by Mr. Robinson, Assistant Director of Agriculture; on the Cuttack Farm up to 1915-16, after which they were designed by Mr. Sethi, Deputy Director of Agriculture; on the Sabour Farm in 1912-13, after which Mr. McGowan, the Professor of Agriculture, was responsible, though the majority of the rice experiments there were actually carried out by Mr. Sil, the Assistant Professor of Agriculture. In certain experiments I have recorded the results in a different form to that in which they were given in the yearly farm reports, and have sometimes drawn different conclusions from them.